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Graduate Education and Simulation Training for CBRNE Disasters Using a Multimodal Approach to Learning

Part 2: Education and Training from the Perspectives of Educators and Students

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14. ABSTRACT

The Simulation and Modeling Center at the Chemical Casualty Care Division (CCCD) of the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) approaches education and training from a human-performance perspective and uses an integrated multimodal approach that includes lectures, human actors, manikins, a cholinergic-crisis laboratory exercise, tabletop exercises, and computerized modeling and simulation. Part 1 of this two-part series provided an overview of teaching at CCCD and explored theories of learning. Part 2 describes the multiple modalities used by the USAMRICD Simulation and Modeling Center to educate students and reviews an unpublished 2006 CCCD study on the efficacy of various CBRNE training modalities (including simulation using a nonhuman primate) from a student's perspective. The results provide a benchmark for manikins and computer simulations to use in future CBRNE training. As of November 2011, the course no longer used nonhuman primates, they had been replaced with manikins which had been in development for years. Therefore the course is in compliance with DoD policy Department of Defense Instruction (DoDI) 3216.01, Use of Animals in DoD Programs, September 13, 2010. In addition, the importance of training as a team in simulation training is addressed.

15. SUBJECT TERMS

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"Not everything that can be counted counts, and not everything that counts can be counted." Albert Einstein[1]

ABSTRACT. The Simulation and Modeling Center at the Chemical Casualty Care Division (CCCD) of the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) approaches education and training from a human-performance perspective and uses an integrated multimodal approach that includes lectures, human actors, manikins, a cholinergic-crisis laboratory exercise, tabletop exercises, and computerized modeling and simulation. Part 1 of this two-part series provided an overview of teaching at CCCD and explored theories of learning. Part 2 describes the multiple modalities used by the USAMRICD Simulation and Modeling Center to educate students and reviews an unpublished 2006 CCCD study on the efficacy of various CBRNE training modalities (including a historic review of a simulation using a nonhuman primate exercise) from a student's perspective. As of November 2011, the courses no longer used nonhuman primates and were replaced with manikins which had been in development for years. Therefore the course is in compliance with DoD policy Department of Defense Instruction (DoDI) 3216.01, Use of Animals in DoD Programs, September 13, 2010. However, the results provide a benchmark for manikins and computer simulations for future CBRNE training. In addition, the importance of training as a team in simulation training is addressed.

Introduction: The Chemical Casualty Care Division (CCCD) of the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), in collaboration with the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) and the Armed Forces Radiobiology Research Institute (AFRRI), oversees and conducts three graduate-level courses to prepare attendees to respond to incidents involving chemical, biological, radiological, nuclear, and explosive (CBRNE) agents. The USAMRICD Simulation and Modeling Center augments standard didactic lectures and discussions by providing a variety of multisensory human-performance-based simulations. Realistic simulation is particularly crucial to medical preparedness since the window of opportunity for saving lives may be brief—in some cases less than ten minutes. For this reason, an intellectual understanding of the effects, diagnosis, and treatment of exposure to these compounds, while necessary, is only a starting point. To result in peak human performance, didactic instruction needs to be supplemented by realistic, intellectually engaging, and challenging tasks. To achieve these goals, students are challenged using various simulation and modeling modalities.

The USAMRICD Simulation and Modeling Center Provides Three Major Modes of Simulation Training:

1) Humans Serving as Models in CBRNE-Exposure Simulations: Students Simulating Reality

Field training exercises (FTXs) are incorporated into the MCBC and FCBC courses and the multistation exercise in the HM-CBRNE course. They model chemical, biological, and traumatic injuries using human actors who mimic the signs and symptoms of CBRNE and trauma casualties. Students selected to play the roles of casualties are moulaged, given situation-specific field medical cards (FMCs), briefed on their assigned scripts, and provided the chance to ask questions and to practice their roles. These roles are designed to portray the effects of various chemical and biological exposures as well as traumatic injuries and psychological overlays. Simulated patients and the remainder of the students, who act as care providers, wear chemical protective clothing and military respirators during a simulated chemical-attack exercise. Each MCBC and FCBC course includes a triage exercise in which students have two minutes to evaluate, triage, and begin to simulate treatment for each of a dozen student actors portraying chemical and biological casualties. In the final FTX in the FCBC course, students position themselves at the various stations (the arrival point, triage, the hot-zone emergency-medical-treatment station, the decontamination corridor, the liquid-control line, and the collective-protection medical-treatment area) of the casualty-collection point at the FTX site. They set up the site, determine casualty flow, and decide where to station limited assets and how to communicate during personnel decontamination activities. Student patients must be triaged, medically managed, decontaminated, and moved to definitive medical care with attention to good medical practice and safety considerations. The FTXs give the

students the opportunity to put into practice what they have learned from earlier lectures, discussions, and simulation and modeling exercises.

2) Human-Manikin Simulators and Computer-Based Training Aids: Using Technology to Improve the Educational Experience

The USAMRICD Simulation and Modeling Center currently uses 30 human-manikin simulators, 26 of which are used for basic modeling of chemical-agent injuries and wounds. Four of the manikins are the most advanced models, initially developed to model physiological parameters associated with trauma and trauma treatment. These instrumented human-like manikins are in the early stages of simulator evolution in attempting to provide realistic signs and symptoms of a cholinergic crisis. CCCD has been working closely with the manufacturer to model key elements of cholinergic crisis and to develop new operating protocols and upgraded components.

In addition, the center uses M256-A1 chemical-agent detector kits, ten robotic manikins, and task trainers. For example, airway simulators and manikin arms allow students to practice intubation and intravenous access, respectively, while in full chemical protective gear. Additional simulation and education technologies developed at the USAMRICD include many computer-based CDs, DVDs, and self-running narrated chemical-agent presentations.[2] Also included are handbooks, textbooks, tri-service training and field manuals, and other publications developed by chemical-casualty-care subject-matter experts.[3,4,5,6,7,8]

3) Historical Look at Past Practices: Use of a "Nonhuman-Primate (NHP) Cholinergic-Crisis Exercise in Replicating the Emotive Component through Diagnosis, Monitoring, and Responsibly Treating a Living Victim of a Simulated Nerve-Agent Exposure"

Note: As of November 2011, the courses omitted the use of nonhuman primates; they were replaced with manikins which had been in development for years. Therefore the course is in compliance with DoD policy Department of Defense Instruction (DoDI) 3216.01, Use of Animals in DoD Programs, September 13, 2010.[9]

Nonhuman primates (NHPs) are remarkably similar anatomically and physiologically to humans and are thus the most applicable live-animal models of a cholinergic crisis in human casualties. The NHP cholinergic-crisis exercise previously offered in the MCBC and FCBC courses was the only known student exercise in the world to offer healthcare providers direct interaction with a live-animal simulated nerve-agent casualty under controlled conditions such that participants could assess and manage the animals and evaluate the effects of the nerve-agent simulant and its treatment from before exposure through the resolution of signs and symptoms following treatment. The NHP cholinergic-crisis laboratory exercise was approved at two levels, 1) the federally

mandated Institutional Animal Care and Use Committee (IACUC) at the USAMRICD and 2) the U.S. Army Medical Research and Materiel Command (MRMC) Animal Care and Use Review Office, in accordance with regulatory requirements AR 40-33 and Department of Defense (DoD) Instruction 3116.01. The NHP cholinergic-crisis exercise in the MCBC and FCBC courses was conducted under an approved protocol in strict compliance with the *Guide for the Care and Use of Laboratory Animals*, the federal Animal Welfare Act and Regulations, and all other applicable federal, DoD, and U.S. Army regulations. The USAMRICD animal care and use program is accredited by the Association of Assessment and Accreditation of Laboratory Animal Care International (AAALAC). In the NHP cholinergic-crisis exercise, participants observed and treated anesthetized NHPs exposed to the carbamate nerve-agent simulant physostigmine, which is FDA-approved for the diagnosis and treatment of myasthenia gravis. Physostigmine is a short-acting drug that reliably induces the cholinergic signs of increased secretions (lacrimation, hypersalivation, bronchorrhea, and diaphoresis), bronchospasm, apnea, fasciculations, and possible seizure activity.

The vervet monkey (*Chlorocebus aethiops sabaeus*) was an appropriate NHP model for use in this exercise because its response to physostigmine administration so closely mimicked the human response to nerve-agent exposure. This species is also similar to man in its response to treatment against cholinesterase inhibitors. Exposed animals were observed and medically supported until approximately ten minutes after exposure; the effects were then reversed with atropine, and diazepam was also given if seizures developed. The animals were carefully monitored and supported by well-trained veterinary staff before, during, and after the exercise. The animals recovered completely and displayed no behavioral or physical adverse effects from the laboratory exercise. In the experience of the USAMRICD, the use of a multimodal approach that included additional simulation modalities (e.g., briefings, videos, manikins) leading up to the NHP cholinergic-crisis laboratory exercise was a very effective educational approach to replicate the emotive while teaching students to manage a cholinergic crisis. Course attendees typically reported that their monitoring (through seeing, hearing, and palpating) and subsequently successfully treating the physostigmine-exposed NHPs did more for their education and skills-focused hands-on training (and for their confidence in their ability to treat human nerve-agent casualties) than any other single activity in the course. A description of an unpublished study conducted at the USAMRICD supports the educational value that students obtained via this exercise and is provided below.

Student Learning and Student Perceptions of the NHP Exercise:

The purposes of a previously unpublished study, "An Evaluation of Student Learning and Student Perceptions of Learning during a Primate Lab Cholinergic Crisis Medical Response Exercise, 2006," by Boardman et al.[10] were 1) to measure the value of cholinergic-crisis educational and training experience via a comparison of didactic

lectures, viewing of videos of exposed animals, and participation in an interactive NHP cholinergic-crisis exercise and 2) to assess the educational perceptions of the learning value of the three educational experiences among those participants.

Methods: This study was conducted as part of pre-approved educational training protocols, and since all participants received the same training, no Human Use Committee approval was required. Participants were given objective 15-question pre-activity and post-activity tests on the identification of signs and symptoms of a cholinergic crisis. Additionally, a 24-question subjective survey administered to both groups after the completion of the purely voluntary NHP exercise (students were free to decline to participate) was used to evaluate student perceptions of the educational effectiveness of the primate exercise. The content of the survey consisted of a series of statements related to the exercise. Students rated their level of agreement with the statements, and these responses were graded using a Likert scale. Available responses were (1) Strongly Disagree, (2) Mildly Disagree, (3) Undecided/Don't Know, (4) Mildly Agree, and (5) Strongly Agree. Statements surveyed students' perceptions of their level of understanding of nerve-agent treatment, their memories of signs and symptoms of cholinergic excess, their perceived learning benefits, and their level of confidence in treating a cholinergic crisis.

Participants: A total of 303 students (including physicians, veterinarians, nurses, physician assistants, medics, and corpsmen) who attended the MCBC course (n = 169) or the FCBC course (n = 134) between February and May 2006 were evaluated for their short-term learning and personal perceptions of the educational value of the NHP cholinergic-crisis exercise.

Results: The 15 multiple-choice questions of the identical pre-exercise and post-exercise examinations addressed the identification of signs and symptoms, diagnosis, and treatment of an individual in cholinergic crisis and were analyzed using a two-factor analysis-of-variance (ANOVA) that compared the test scores from the FCBC and MCBC classes as well as the pre-exercise and post-exercise groups. The mean knowledge test scores of students who took the test before and the students who took the test after attending the NHP cholinergic-crisis exercise for the FCBC class was 64.9% versus 70.7% respectively, and those for the MCBC class were 72.3% versus 80.1% respectively. For both the FCBC and MCBC classes, the mean test scores after the exercise were significantly greater than the test scores before the exercise ($p<.05$).

There were groups of three questions that asked about learning/understanding after the lecture; the lecture and video; and the lecture, video and lab. All students answered all three questions in the group.

At the end of the class, all students were asked a series of questions assessing their understanding of nerve agent exposures and treatments and confidence in identifying a cholinergic crisis. Only 39.5% (+/- 12.8%) of the students believed they had a good understanding after the lecture only; 58.8% (+/- 8.7%) of the students believed they had a good understanding after the lecture and video; and 94.5% (+/- 1.0) of the students believed they had a good understanding after the lecture, video and NHP lab.

Overwhelmingly, the NHP cholinergic-crisis exercise was shown to be an important tool for both education (knowledge-focused learning) and training (skills-focused training) in the diagnosis and management of nerve-agent poisoning.

In the survey section of the study, 229 of 303 students responded. The overwhelming majority, 96% (219/229), of students supported the NHP exercise; 4% (10/229) did not fully support the experience. One insightful comment is provided below.

> "As an MD, I have treated myasthenia crisis and delirium tremens. I can say definitely, that actual[ly] seeing and doing the treatment is far more effective. Furthermore you recall symptoms, changes with treatment, and can address complications better because of the experience. Reading is a poor substitute. Videos are better than reading but as 2D presentations, fail to result in genuine understanding, and are limited/orchestrated for finite information, NOT appropriate for evaluation and treatment of multivariate possibilities that may be unforeseen. Confidence is built by experience. Do one, see one, teach one… [leads to the] BEST confirmation of understanding and ability to perform - especially in the field or if we are called to teach other people this skill."

Discussion: We speculate that the didactic lectures and video presentation provided the foundation for the successful medical management during the NHP cholinergic-crisis exercise. Because of the use of the emotional component treating a live animal, we believe that the exercise helps to encode this memory more effectively for further recall during emergency situations. Anecdotally, comments from students have indicated that the thing they remember most from MCBC and FCBC courses even decades later is the NHP exercise. Further, the NHP exercise challenged students' decision-making abilities beyond reacting to the limited preprogrammed responses that currently are the state-of-the-art for manikins. Since no two animals reacted the exact same way when given the nerve-agent simulant (physostigmine) or standard medical treatment (atropine and diazepam), students were challenged to titrate medications to each animal's differing degrees of airway resistance and excess secretions and to its individual susceptibility to seizure activity. In the future, such variability programmed into the advanced human simulators/manikins will bring more life to the exercise and enhance the encoding of the human brain.

Other Live-Animal Studies That Have Addressed the Use of Multiple Methodologies for Medical Training and Education:

Previous efforts have been made to quantify learning effectiveness and retention rates by comparing didactic lectures, reading, audiovisual presentations, demonstrations, discussion groups, practice sessions, and teaching of others. A comparison of the CCCD study to the oft-cited National Training and Learning Institute projected learned retention rates using various educational methodologies suggests that the more directly involved a student is in a given learning topic, the higher the perceived educational value for the student (see Figure 1).[11]

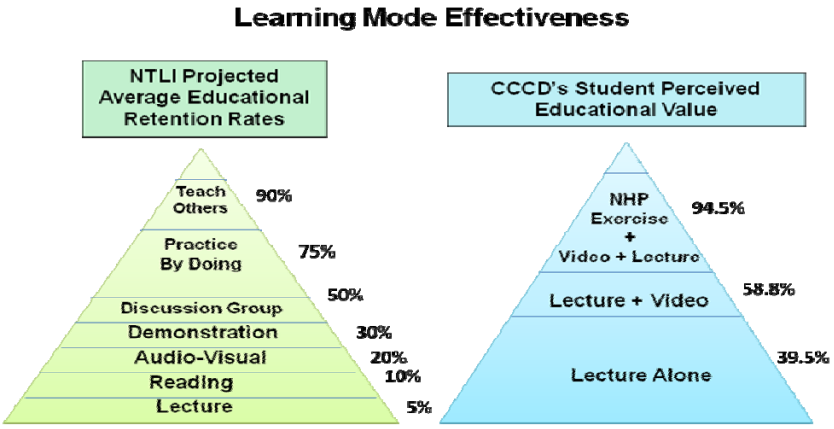

Figure 1. National Training and Learning Institute Projected Retention Rates Compared to CCCD Empirical Study

Of the numerous studies reviewing the efficacy of training medical personnel for combat and for handling mass-casualty incidents, two are particularly insightful. In a 2007 study by Sohn[11] examining simulation using human-simulator and live-animal models, 65% of military primary-care resident physicians (family physicians, psychiatrists, and geriatricians) who had limited trauma training responded that simulation training had a high impact on improving their manual skills in preparing them to treat combat trauma. Pre-course and post-course tests were administered to 31 of 60 participants. The mean test scores improved from 76% to 96% ($p<0.01$). Likert-scale responses (from 1 = not confident to 5 = confident) improved from an average of 2.3 before the course to 3.9 upon completion of the course ($p<0.01$). Only 17% of respondents before training reporting feeling confident in caring for casualties in battle; after training, this percentage rose to 75% ($p<0.01$). This study concluded that military primary-care resident physicians can and should be expected to provide competent trauma care if they successfully complete a training program integrating lectures, medical simulators, and live-tissue training.[12]

In a second 2007 study,[13] Sohn examined student perceptions from a training course using a hybrid education-and-training program consisting of didactic sessions, simulation training, case presentations, and an animal exercise and found that the mean Likert-scale live-animal score (2.6) was significantly higher ($p<0.01$) than the mean score (1.5) for the manikin portion of the training. A particular observation in this investigation emphasized the need for real-life training: Early during training, many young combat medics "froze" at first when seeing a seemingly uncontrollable hemorrhage from a proximal-artery injury in a live-animal model and had to be "coaxed" to act. Importantly, this study reported that 138 of 140 (99%) of medics who deployed to Iraq for one year reported that the principles that were taught during their multimodal training helped with actual battlefield management of injured casualties.[14]

The Current Roles of Simulation Modalities in CBRNE Training:

One key focus area of the training in the MCBC and FCBC courses is the preparation of students to diagnose and treat a cholinergic crisis under stressful conditions using a multimodal approach. The USAMRICD Simulation and Modeling Center now employs manikins and live actors to replace the nonhuman-primate (NHP) cholinergic-crisis exercise to accomplish this goal. The NHP exercise provided the most realistic simulation of the emergency medical response to a victim in cholinergic crisis resulting from an anticholinergic agent, whether a carbamate compound, an organophosphorus (OP) insecticide, or a nerve agent. However, CCCD believes that manikins and live actors are continually improving and will someday be able to elicit the same or better educational experience that enhances student understanding of the clinical presentation of cholinergic-crisis casualties and gives these students the confidence and skills to identify and manage a chemical nerve-agent casualty successfully.

Throughout the medical-educational community, there has been a noticeable trend toward the use of manikin simulators as adjuncts to or even replacements for live-animal training. The Use of Live Animals in Medical Education and Training (ULAMET) Joint Analysis Team was established to address technology maturity and readiness of simulations to replace the use of live animals in DoD medical education and training. The ULAMET technical report ultimately recommended an optimal solution of hybrid (multimodal) technological applications encompassing virtual environments, manikins, and real-world medical training.[14]

Incorporation of Virtual-World Multimodal Training Efforts and Team Training:

Virtual-world technologies show promise for future CBRNE courses, and educational, training, modeling, and simulation systems should be designed to anticipate human error and to mitigate their consequences.[15] As technology evolves, a virtual teaching environment may someday surround each student with the sounds, visuals, kinesthetics,

and even odors of a chemical event. It is vital that the development of these virtual-world technologies be as realistic as possible to provide the proper educational experience to individuals and teams during a CBRNE event. Systematically educating and training students at stress levels that correlate with improved performance is key to achieving peak performance levels.[16] It is important not only to integrate emerging technologies but also to include methodologies that improve individual and team cognitive approaches. One tool that has been introduced in the MCBC and FCBC courses is Crew Resource Management (CRM), a method that leads to improved peak performance and has been shown to reduce human error. CRM development of better situational awareness, understanding of personalities, communication skills, problem solving, and decision making in individuals and teams has shown to be quite effective. For example, the employment of CRM has been credited with a 51% decrease in aircraft accidents in U.S. Air Force transportation-aircraft missions from 1986 through 1990.[17] CRM approaches to increase safety and reduce accidents are now being employed in the offshore industry, in nuclear power plants, and in the medical community, for example, in Anesthesia Crisis Resource Management training.[18,19] The training goal is to provide the technical skills and confidence to make key medical decisions, utilizing a virtual-human model that demonstrates variable physiological reactions to specific medical treatments and prepares students to manage a mass-casualty CBRNE event when they are presented with incomplete and conflicting information.[20]

Summary: The professional cadre of physicians, nurses, and other military and civilian personnel at CCCD, in collaboration with professional staff from the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) and the Armed Forces Radiobiology Research Institute (AFRRI), develops, organizes, and implements postgraduate CBRNE medical-education programs for healthcare professionals, including first responders, first receivers, hospital administrators, and medical planners. The three CCCD-administered medical-education courses (MCBC, FCBC, and HM-CBRNE) are accredited for continuing-medical-education (CME) and continuing-education-unit (CEU) credits for physicians, nurses, and paramedical professionals.

These courses are unique, graduate-level training programs in which realistic, hands-on training is conducted for healthcare providers. The USAMRICD Simulation and Modeling Center supplements traditional didactic teaching methods by using human modeling and manikins in all three courses. The now-replaced NHP cholinergic-crisis exercise had been an overwhelmingly positive learning experience for students for over 30 years. A review of an unpublished CCCD study was conducted to begin to quantify what type of training is most beneficial in the CBRNE area. The data demonstrated that students' confidence levels for treating and identifying nerve agent casualties were significantly higher (94.5%) after a combination of a lecture, a video introduction to the NHP cholinergic-crisis exercise, and hands-on participation in the NHP exercise than after the combination of a lecture and a video (58.8%) and after a lecture only (39.5%).

Future technological innovations must meet the challenge of developing an emotive response to diagnosing, monitoring, and treating as was previously done with a live-animal exercise. As of November, 2011, manikins that had been in development replaced the NHP cholinergic-crisis exercise in the MCBC and FCBC courses. Therefore the course is in compliance with DoD policy DoDI 3216.01, Use of Animals in DoD Programs, September 13, 2010. Manikin models are in the early stages of development compared to their aviation counterparts, and reliability and validity standards are still evolving. Department of Defense medical personnel and civilian counterparts, performing individually or as a team, need to be fully trained to treat and manage patients under the most stressful conditions. The current evidence strongly suggests that using an integrated multimodal approach including lectures, human actors, future advanced manikins mimicking a cholinergic-crisis exercise, tabletop exercises, and computerized modeling and simulation is the best way to educate and train those who are charged to manage a catastrophic CBRNE event.

REFERENCES

1. Quote: "Not everything that can be counted counts, and not everything that counts can be counted." Sign hanging in Albert Einstein's office at Princeton. Available at http://www.rescomp.stanford.edu, collected quotes. Kevin Harris, 1995; accessed Jul 12, 2010.

2. List of Chemical Casualty Care Division electronic educational tools: Chemical Biological Mask Maintenance, and Operations/MOPP Donning training video and CD; the Medical Management of Nerve Agent Casualties/Virtual Nerve Agent Casualty-Assessment Exercise (a computer-based game-like teaching module); the Nerve Academy 1.0/SIMapse Nerve-Agent Laboratory (an interactive self-study computer-based teaching module for nerve-agent toxicology and medical management); SIMAPSE 3/Nerve Academy, as of 2011.

3. Tuorinsky S: Medical Aspects of Chemical Warfare, United States Dept. of the Army, Office of the Surgeon General, Borden Institute, Walter Reed Army Medical Center, 657, 2008.

4. Hurst G: The Medical Management of Chemical Casualties Handbook*;* 4th edition, U.S. Army Medical Research Institute of Chemical Defense, Chemical Casualty Care Division, 2007.

5. Hurst G, The Field Management of Chemical Casualties Handbook; 3d edition, U.S. Army Medical Research Institute of Chemical Defense, Chemical Casualty Care Division, 2007.

6. Woods J: The Medical Management of Biological Casualties Handbook; 6th edition, U.S. Army Medical Research Institute of Infectious Diseases, 2005.

7. The U.S. Army Field Manual 8-284 (quad Service), 2000.

8. The Medical Management of Radiological Casualties, 3d edition, Armed Forces Radiobiology Research Institute (AFFRI), 2009.

9. DoD policy Department of Defense Instruction (DoDI) 3216.01, P. 2, Paragraph 4b, Use of Animals in DoD Programs September 13, 2010.

10. Boardman C; Hill B, Lee R, Despain K, Armstrong K, Hurst C, Armstrong K, Hildabrand A, Talbot T, Schultheiss P: An Evaluation of Student Learning and Student Perceptions of Learning during the United States Army Medical Research Institute of Chemical Defense (USAMRICD) Primate Lab Cholinergic Crisis Medical Response Exercise. Unpublished study conducted at the USAMRICD Chemical Casualty Care Division, 2006.

11. National Training Laboratory Institute for Applied Behavioral Science. Available at http://www.ntl.org/, accessed 10 Nov 2010.

12. Sohn V: Training Physicians for Combat Casualty Care on the Modern Battlefield. Journal of Surgical Education, 2007, Vol 64/Number 4, Jul/Aug.

13. Sohn V: From the Combat Medic to the Forward Surgical Team: The Madigan Model for Improving Trauma Readiness of Brigade Combat Teams Fighting the Global War on Terror. Journal of Surgical Research, 2007, 138, 25-31.

14. Foster R, Embrey E, Smith D, Hildabrand A, Cordts P, and Boyer M: Under Secretary of Defense (Acquisition, Technology and Logistics) Defense Pentagon YAS (AR&L), Final Report on the Use of Live Animals in Medical Education and Training Joint Analysis Team, 12 Jul 2009.

15. Reason J: Human Error; Models and Management. British Medical Journal 2000; 320:768-770.

16. Nixon P: Stress Performance Curve, 1979, Available at www.lessstress.net/stress-affect-performance.htm; accessed Aug 16, 2010.

17. Federal Aviation Administration, Team Performance Human Error Management, Cockpit Resource Management. Available at https://www2.hf.faa.gov; accessed Mar 26, 2011.

18. Helmreich R, Musson D, Sexton J: Human Factors and Safety in Surgery, research sponsored by the Federal Aviation Administration. Department of Psychology, University of Texas Human Research Project, The University of Texas at Austin. p.13, 2004. Can be accessed at homepage.psy.utexas.edu.

19. Geller E, Barr J, Lighthall G, Bertaccini E, Dirks J, Perez F, Gaba D, Howard S, Sowb Y, Bushell E: Crisis Resource Management Training in the Intensive Care Unit: Subjective Assessment of ACRM-LIKE Training for Hospital ICU Personnel. Presented at the 2002 International Anesthesia Research. Society Meeting. Available at http:www.med.stanford.edu/VAsimulator/crisis.html; accessed Mar 29, 2011.

20. Kyle R, Via D, Lowy R, Madsen J, Marty, A, Mongan P: A Multidisciplinary Approach to Teach Responses to Weapons of Mass Destruction and Terrorism Using Combined Simulation Modalities. Jr of Clinical Anesthesia 16:152-158, Mar 2004.